1. Bi-Directional Logic Level Converter Hookup Guide

https://learn.sparkfun.com/tutorials/bi-directional-logic-level-converter-hookup-guide/all

Do you have a 3.3V I2C or SPI sensor that might go up in smoke if connected to a 5V Arduino? Or a 5V device that needs a workaround to be compatible with your 3.3V Raspberry Pi 4, Raspberry Pi Zero, RedBoard Turbo, RedBoard Turbo or Arduino Due?

To get over this obstacle you need a device that can shift 3.3V up to 5V or 5V down to 3.3V. This is called logic level shifting. Level shifting is a dilemma so common we designed a simple PCB assembly to make interfacing devices a little easier: the Bi-Directional Logic Level Converter.

Though they're share the same shape and size, this bi-directional logic level converter shouldn't be confused with the more “uni-directional” version. This converter can pass data from high to low and/or low to high on all channels. It's perfect for level-shifting between devices that are sharing a data wire, like I2C or a one-wire interface.

1.1. Covered In This Tutorial

In this tutorial we'll take an in-depth look at the Bi-Directional Logic Level Converter. We'll examine the schematic and board layout – explaining what each pin on the board does. At the end we'll go over some hookup examples to show how you might hook the board up for various interfaces.

1.2. Board Overview

If you take a peek at the board's schematic, you'd find that the bi-directional logic level converter (let's shorten that to BD-LLC) is actually a very simple device. There is basically one level-shifting circuit on the board, which is repeated four times to create four level-shifting channels. The circuit uses a single N-channel MOSFET and a couple pull-up resistors to realize bi-directional level shifting.

Through some semiconductor magic, this circuit can shift a low voltage signal to high and/or shift a high-voltage signal to a low voltage. A 0V signal on one end remains a 0V signal on the other. For a complete analysis of this circuit, check out this excellent

Philips Application Note AN97055

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1.3. The Pinout

There are 12 total pins on the BD-LLC – two parallel rows of six headers. One row contains all of the high voltage (e.g. 5V) inputs and outputs, the other row has all things low voltage (e.g. 3.3V).

The pins are labeled on both the bottom and top sides of the board, and organized into groups. Let's look closer at some of the pin groups:

1.3.1. Voltage Inputs

The pins labeled HV, LV, and two GND's provide high and low voltage references to the board. Supplying a steady, regulated voltage to both of these inputs is required.

The voltage supplied to the HV and GND inputs should be higher than that supplied to the LV side. For example, if you're interfacing from 5V to 3.3V, the voltage on the HV pin should be 5V, and the voltage on LV sould be 3.3V.

1.3.2. Data Channels

There are four separate data channels on the BD-LLC, each capable of shifting data to and from high and low voltages. These pins are labeled HV1, LV1, HV2, LV2, HV3, LV3, HV4, and LV4. The number at the end of each label designates the channel of the pin, and the HV or LV prefix determines whether it's on the high or low side of the channel.

A low-voltage signal sent in to LV1, for example, will be shifted up to the higher voltage and sent out HV1. Something sent in HV3 will be shifted down and sent out of LV3. Use as many of these channels as your project requires. You don't have to use every single one.

Keep in mind that these level shifters are purely digital. They can't map an analog voltage from one max voltage to another.

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